Remarks

Claims 1, 2, 14, 17 and 18 are pending in the present application and are rejected.

1. Rejection Under 35 U.S.C. §103(a)

Claims 1-2 and 17-18 are rejected under 35 U.S.C. §103(a) as being unpatentable over Tamatsuka et al. (U.S. Patent No. 6,139,625) in view of Luter et al. (U.S. Patent No. 6,053,974) along with Aratani (DE 3701811), an English Abstract has been provided.

Applicants respectfully traverse this rejection for the reasons set forth below and in previous responses. The Examiner has inappropriately used hindsight to reconstruct the present invention as disclosed in claims 1-2 and 17-18 in a piecemeal approach from the Tamatsuka et al., Lurer et al. and the Aratani references. First, the Examiner uses Luter et al. to provide the heat shield which is missing in Tamatsuka et al. Next, the Examiner uses Aratani to provide the traveling magnetic field missing from both Tamatsuka et al. and Luter et al. Moreover, the Examiner completely neglects the fact that the Aratani reference teaches away from the present invention thereby making its combination with Tamatsuka et al. and/or Luter completely inappropriate.

The Examiner concedes that the "combination of Tamatsuka et al. and Luter et al. is silent to exposing the silicon melt to an influence of a traveling magnetic filed which exerts a substantially vertically orientated force on the melt in a region of the crucible wall." (Office Action dated April 4, 2005). The Examiner relies on Aratani to provide this missing element in reconstructing the present invention. Specifically, the Examiner states that:

> In a method of producing a single crystal using the Czochralski method, Aratani teaches applying a downwardly traveling magnetic field to the melt in the crucible, this reads on applicants' vertically oriented force. Aratani also discloses a

> single magnetic field application device 8, note Figure 1, this reads on applicants' except for the traveling magnetic field no further magnetic field being applied to the melt.
>
> Office Action dated April 4, 2005

Moreover, the Examiner incorrectly attempts to justify the combining of Aratani with Tamatsuka et al. and Lurer et al. by stating:

> Travelling magnetic field are known in the art to be **advantageous in minimizing dissolution of oxygen from the silica material of a crucible and for stirring a melt in Czochralski processes**, as evidenced by Aratani (DE 3701733) and Szekely et al (US 5,196,085) below. Therefore, it would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Tamatsuka et al and Luter et al by applying a traveling magnetic field, as taught by Aratani to minimize dissolution of oxygen fi'om the silica of the crucible and for stirring the melt, which is desirable.
>
> Office Action dated April 4, 2005 (emphasis added)

The Examiner completely neglects that the present invention is different and oxygen dissolution is not minimized in the first embodiment. The Specification clearly states:

> Surprisingly, the effect of the **oxygen levels being reduced**, which is described in DE-37 01 733 A1, **does not occur** when the invention is carried out in accordance with a **first embodiment**. It is assumed that the reason for this is that, when a single crystal is being pulled in accordance with DE-37 01 733 A1, the **upwardly directed thermal convection** is decelerated by applying a **traveling magnetic field with the force directed downward**. Consequently, the flow velocity which is responsible for the oxygen transport and the inclusion of oxygen in the silicon single crystal is slowed by the influence of the magnetic field. Therefore a larger quantity of oxygen can escape via the surface of the melt in the form of SiO, and accordingly less oxygen is included in the single crystal.

Specification, paragraph 10 (emphasis added)

The differences between the results of Aratani and the present invention can be attributed to differences in the convective flows. Specifically, the Specification explains this difference from Aratuni by stating:

> By contrast, in the present invention it is not the rate of flow, but rather it is the **direction of flow**, which plays the decisive role. When pulling a silicon single crystal with a diameter of at least 200 mm out of a crucible with a diameter of at least 450 mm, with a traveling magnetic field applied with its force directed downward (first embodiment of the invention), the direction of flow is no longer directed upward, toward the surface of the melt. Rather, **convection is established, which is initially directed toward the base of the crucible and later toward the growing single crystal**. As a result, oxygen is included in the growing silicon single crystal at a virtually constant rate. This occurs even though a crucible promotes the evaporation of SiO out of the melt, since it allows a relatively large open surface of the melt to be used.

Specification, paragraph 11 (emphasis added)

The Specification explains the differences between Aratani and the present invention are the result of differences in the direction of convective flow which is of course is on average from a hot to cooler location. Of course, this difference between the flow directions (i.e., convection) must be present in independent claims 1, 17, and 18 if these claims are to be patentable. Indeed, this difference is at least in part manifested in these claims by the inclusion of a heat shield. The Specification explains that the heat shield "promotes the evaporation of SiO out of the melt, it does this by **increasing the temperature of the melt surface.**" Clearly, the inclusion of the heat shield increases the surface temperature of the melt which inevitably affects the convective flows in the melt. Since the first embodiment of the invention does not lead to a decrease in oxygen levels as desired by Aratani, Aratani teaches away from the inclusion of a heat shield when a downwardly directed magnetic force is used. Accordingly, the combination of Aratani with Tamatsuka et al. and Lurer et al. is incompatable.

For the reasons set forth above, claims 1-2 and 17-18 are allowable over the combination of Tamatsuka et al., Lurer et al., and Aratani.

Claim 14 is rejected under 35 U.S.C. 103(a) as being unpatentable over Tamatsuka et al. (U.S. Patent No. 6,139,625) in view of Luter et al. (U.S. Patent No. 6,053,974) along with Aratani (DE 3701811), as applied to claims 1-2 and 17-18 above, and further in view of Lari et al.(U.S. Patent No. 4,905,756) or Morishita et al. (JP 61-029128).

Claim 14 is patentable over the combination of Tamatsuka et al., Luter et al., Aratani and for the same reasons as set forth above. Similarly, neither Lari et al. nor Morishita et al. disclose the utilization of a heat shield nor the motivation to combine such a heat shield with a traveling magnet field in a process for producing a silicon single crystal. It must also be appreciated that utilization of both Lari et al. and Morishita et al. is inappropriate since each reference is non-analogous. Lari et al. discloses "an apparatus and method that combine a levitation magnet that produces low frequency magnetic field traveling waves with a stabilization magnet that produces a high frequency magnetic field to retain a metal in liquid form with a smooth vertical boundary." (Lari et al., col. 3, ll. 33-38.) Morishita et al. provides a process for uniformly etching "a sample at a high speed or to form a uniform and thick film on the sample by providing magnetic field generating means for electrically generating a magnetic field." (Morishita et al., Abstract) As such, each of these references are in no way related to the field of growing silicon single crystals.

Conclusion

Applicant has made a genuine effort to respond to each of the Examiner's rejections in advancing the prosecution of this case. Applicant believes that all formal and substantive requirements for patentability have been met and that this case is in condition for allowance, which action is respectfully requested. If a telephone or video conference would help expedite allowance or resolve any additional questions, such a conference is invited at the Examiner's convenience.

The Examiner is authorized to charge any additional fees or credit any overpayments as a result of the filing of this paper to our Deposit Account No. 02-3978 -- a duplicate of this paper is enclosed for that purpose.

Respectfully submitted,

Janis Virbulis et al.

By _____
James W. Proscia
Reg. No. 44,364
Attorney/Agent for Applicant

Date: July 5, 2005

BROOKS KUSHMAN P.C.
1000 Town Center, 22nd Floor
Southfield, MI 48075-1238
Phone: 248-358-4400
Fax: 248-358-3351